α DECAY OF Ac^{225}

B. S. DZHELEPOV, R. B. IVANOV, and L. N. MOSKVIN

Submitted to JETP editor July 20, 1962

J. Exptl. Theoret. Phys. (U.S.S.R.) **43**, 2077-2079 (December, 1962)

The α-spectrum of Ac^{225} was investigated by means of a magnetic α-spectrometer. The energies and intensities of previously known α transitions are in good agreement with the data presented in this paper. At least two new levels with energies at 388 and 544 keV were detected and tentatively assigned to the Fr^{221} nucleus.

THE first data on the α decay of Ac^{225} were obtained by Hagemann.[1] Results of a more detailed investigation of the Ac^{225} α spectrum made by Pilger are given in the book of Perlman and Rasmussen[2] (the results of his work, taken from [2], are given in the table below).

We carried out a new study of the Ac^{225} spectrum with a magnetic α spectrometer with double focusing.[3] To obtain the actinium sample, we bombarded metallic thorium with 660-MeV protons at the synchrocyclotron of the Joint Institute for Nuclear Research. The thorium was then dissolved in 10 ml of an 11.2 N solution of HCl with a small addition of HF (1—2 drops of 2.0 N solution of HF). The solution was carefully evaporated to the smallest possible volume without the appearance of a precipitate, after which it was diluted with distilled water to 10 ml. To the obtained solution, previously heated almost to boiling, we added 10 ml of a 30% solution of H_2O_2. The amorphous precipitate of peroxide compounds of thorium produced in this way was separated in a centrifuge. The actinium was not precipitated with the thorium compounds in appreciable quantities and remained in solution. No check was made for other elements produced in the bombardment of thorium, since they did not interfere with the further separation of the actinium, which took place by a chromatographic technique in a column with Dowex-50 tar.

The actinium sample was sputtered in vacuo on a glass base. Several exposures were made to different regions of the spectrum from 5.9 to 5.2 MeV. The instrument transmission in most runs was 0.21% of 4π and the resolving power was 0.07% for $H\rho$.

Figures 1 and 2 show the results of the measurements. The study of the Ac^{225} α spectrum confirmed the presence of the previously known α transitions. The energies and intensities of these transitions are in good agreement with our data, which are shown in the table.

In the analysis, attention is drawn to the fact that the half-width of the line for the ground-state transition is much larger than the half-width of the remaining lines. This may be due to the fact that the ground-state line is not a single line as it has been regarded till now. We carried out several exposures of this line under different conditions in order to resolve the second line if it exists. However, even under the best resolution attainable with

Data of Perlman and Rasmussen[2]			Our data	
Transition energy, keV		Intensity, %	Energy level, keV	Intensity, %
α_0	5.818	54	0	54
α_1	5.782	28	37	30.7
α_2	5.721	9.5	98	8.1
α_3	5.713	2.6	107	2.1
α_4	5.672	0.8	148	0.95
α_5	5.627	3.8	194	2.9
α_6	5.599	0.6	222	0.5
α_7	5.570	0.7	252	0.6
α_8	5.543	0.07	274	0.08
α_9	—	—	341?	0.02
α_{10}	—	—	388	0.06
α_{11}	—	—	544	0.05

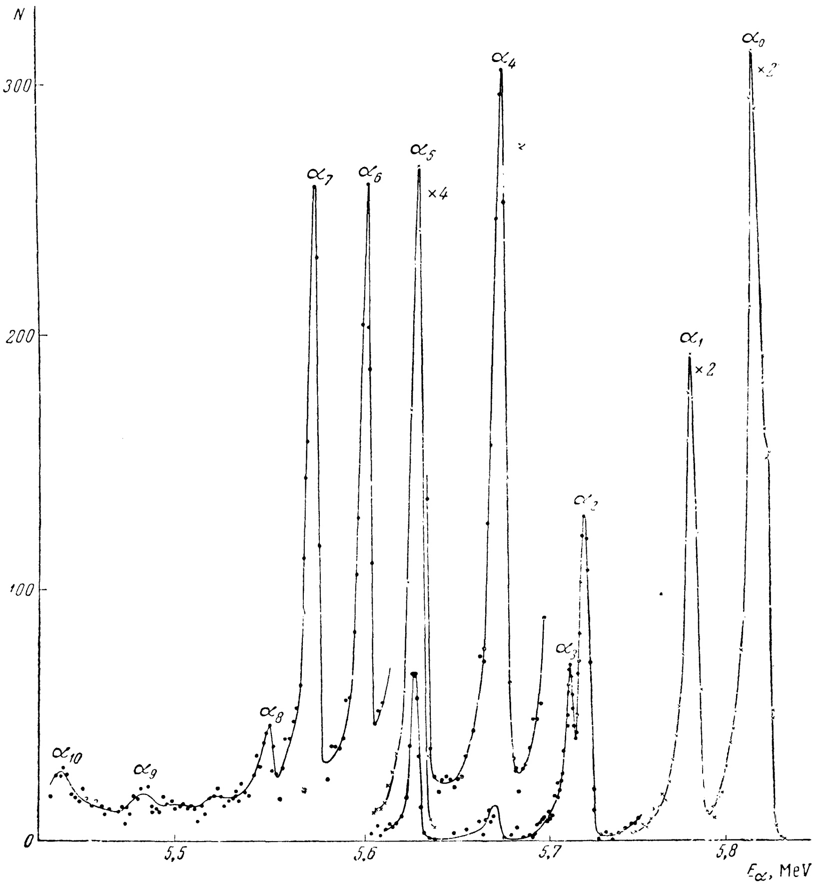

FIG. 1. Region of the Ac^{225} spectrum from 5.45 to 5.85 MeV obtained in two exposures (the number of tracks in a band 0.3 mm wide is given along the ordinate axis here and in Fig. 2).

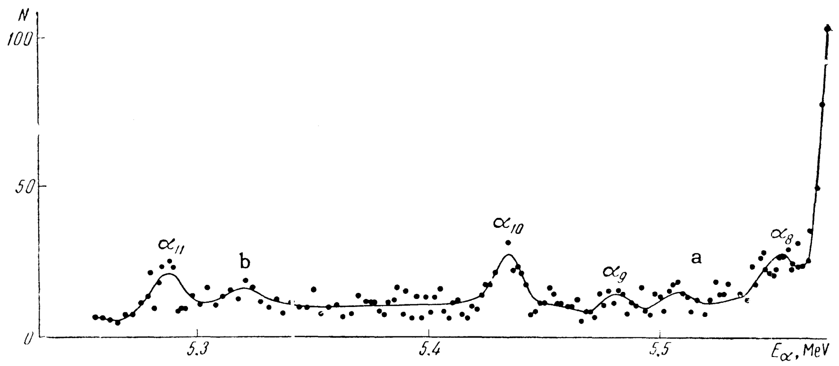

FIG. 2. Region of the Ac^{225} spectrum from 5.25 to 5.45 MeV.

our spectrometer (about 5 keV), we were not able to attain this goal, although in all runs the half-width of the line remained larger than that of the other lines.

The results of these measurements indicate that if this line is double, the difference in energies of the levels for the ground state and first excited state is less than 5 keV, while the intensities of the α transitions to both levels are approximately the same. Also favoring the suggestion that the Fr^{221} nucleus has two close-lying levels is the fact that among the known γ transitions detected in this nucleus[4] are transitions of energy 36.6 and 38.4 keV, which in this case, fit very well into the Ac^{225} decay scheme as transitions from the 38.4-keV level to two low-lying levels.

In the energy region from 5.34 to 5.1 keV, we observed at least two new lines whose energies and intensities are shown in the table. A repeated exposure of this region of the spectrum showed that the intensities of both lines decay with a half-life of ~ 10 days; nevertheless, we cannot unambiguously assign this line to the Ac^{225} spectrum and not to its decay products. In Figure 2, the letters a and b denote the regions in which there is an excess over background, but the large statistical error does not allow any conclusions on the nature of these lines.

Our data are insufficient to permit the construction of the Ac^{225} decay scheme. The assignment of the quantum characteristics for the individual levels requires further investigations.

In conclusion, we consider it our pleasant duty to thank A. G. Dmitriev, V. N. Delaev, and V. F. Rodionov for aid in the measurements. We are deeply indebted to B. K. Preobrazhenskiĭ for consultations on the chemical separation of actinium.

[1] F. Hagemann, Phys. Rev. **79**, 534 (1950).

[2] I. Perlman and J. O. Rasmussen, Alpha Radioactivity, Handb. d. Physik, Band 42, s. 109, Springer Verlag, Berlin, Göttingen, Heidelberg, 1957.

[3] Dzhelepov, Ivanov, Nedovesov, and Chumin, Izv. AN SSSR, ser. fiz. **23**, 782 (1959), Columbia Tech. Transl. p. 780.

[4] Strominger, Hollander, and Seaborg, Revs. Modern Phys. **30**, 585 (1958).

Translated by E. Marquit
356